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ABSTRACT

This student manual for the Miller MRH-5 welding robot contains nine modules on how to: safely operate the MRH-5 robot; recognize different types of data; weld a part programming the MRH-5; re-teach an already taught program; weld various joints with the MRH-5 robot; weld a desk plaque with the MRH-5 robot; perform editing functions; check/edit system data; and perform functions in edit mode. Each module may contain the following: number; task; estimated time; overview; outline; objectives; study guide; lesson; assumptions; summary; examples; and guidelines. Module 10, blank sequence sheets, is not included. (NLA)

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MRH-5 ROBOT/STUDENT MANUAL

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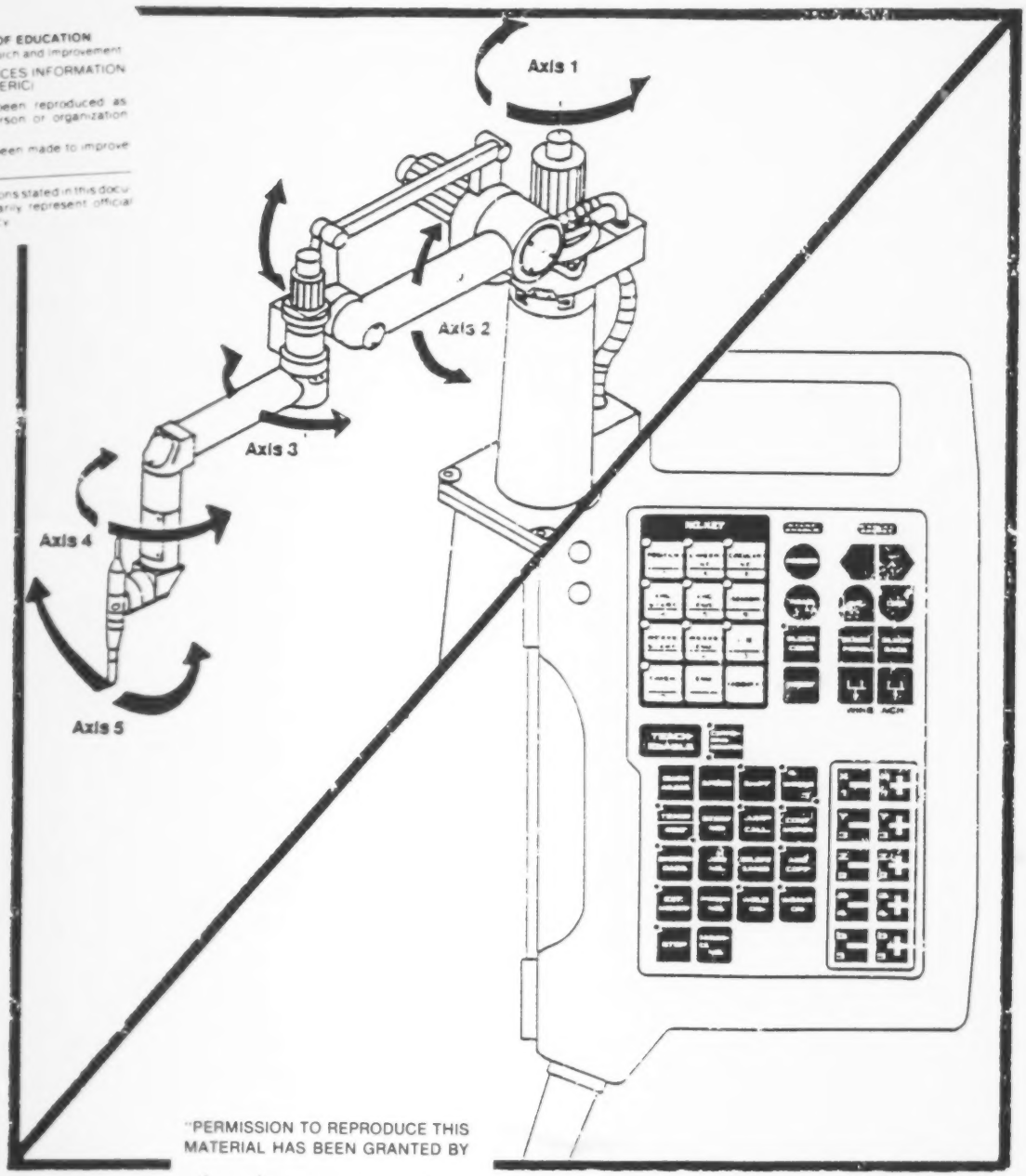

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OneStep®
INDEX SYSTEM

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Cardinal

TASK: To safely operate the MRH-5 Robot.

ESTIMATED TIME: 3 hours

OVERVIEW: This module will cover the safety rules of operating any robot, including the Miller MRH-5 welding robot. This module will also include an overview of the MRH-5, i.e., limits, axis identification, start-up, power down procedure, etc.

OUTLINE:

1. Safety
2. Components
3. Specifications
4. Teach Pendant Identification
5. Powering-Up/Down Procedure And Zeroing Out Robot

OBJECTIVES: Upon completion of this module the student will be able to:

1. Understand all safety rules when programming or operating any robot.
2. Identify the assumptions often overlooked when operating a robot.
3. Identify additional safety precautions outlined in the Miller Operation Manual.
4. List three safety precautions whenever running a robot.
5. Identify the components of the MRH-5 robot.

6. Understand the limits of the MRH-5 robot, (specifications).

7. Identify components of the teach pendant, i.e., axis movements keys, programming keys, etc.

8. Follow a power-up/power-down procedure every time the robot is used.

9. Follow the procedure for zeroing out the MRH-5 robot.

STUDY GUIDE

Instructions

_____ 1. View - (Video), "Safety at Caterpillar".

_____ 2. Read - General Personnel Safety, Page 1-4.

_____ 3. Read - Assumptions, Page 1-5.

_____ 4. Review - ANSI Safety Requirements for Industrial Robots. (Miller Manual)

_____ 5. Review - Safety. (Miller Manual, Section 1)

_____ 6. Review - Specifications. (Miller Manual, Section 2)

_____ 7. Review - Teach Pendant Identification. (Chart)

_____ 8. Read - Powering-Up/Down, page 1-6.

_____ 9. Follow - Zero-Out Procedure. (Miller Manual, Section 4.4)

General Personnel Safety

Both physical barriers and electronics detectors can be used. Some examples of such barriers are:

1. Painted lines on the floor to mark the robot work envelope, operator work area, parts basket area.
2. Chains and guard posts.
3. Safety rails.
4. Wire mesh fence.
5. Electronic sensors, floor mats, etc.

The minimum safety requirements should be safety rails since painted lines are only psychological barriers, and chains and guard posts are not a sufficient physical barrier.

The following safety rules must be observed whenever working with an industrial robot:

Rule #1: Respect the robot. Don't take the robot for granted or make an assumption about the next movement the robot's arm will take.

Rule #2: Know where the closest emergency stop button is at all times.

Rule #3: Avoid pinch points when programming or working in the work cell.

Rule #4: Know the robot. Pay attention to unusual noises and vibrations from the machinery.

Rule #5: Never permit untrained personnel to operate the robot system.

Rule #6: Don't adjust the robot control mechanism without the proper training and supervision.

Assumptions

Be careful of assumptions:

1. If a robot is not moving **do not** assume it is not going to move.

2. If a robot is doing a particular pattern **do not** assume it will continue making that same pattern.

For additional safety precautions. See pages 1.1 thru 1.8 in the Miller Robot Manual.

If the operator remembers the following simple rules above all others, they will never harm themselves or the robot:

1. Never enter the robot work envelope with the robots servos on.

2. Always block through the program before running the program in auto.

3. Make sure you allocate the correct program to the start module.

Summary

Safety is an important factor in robotic cell design, from the beginning of the design to the implementation of the process. Specific areas of safety awareness in a robotic installation include OSHA requirements, types of barriers for worker protection, general personnel safety, and operator and maintenance personnel safety.

Powering Up/Down

In order to avoid a spike that could potentially damage the robot controller, follow these few simple guidelines:

1. **Push** - the emergency stop button on either the teach pendant or start module.

2. **Turn Off** - the main power switch on the controller.

3. **Turn Off** - the quick disconnect box.

It is not always necessary to shut power down any farther than from the teach pendant. Remember that if power is turn off to the quick disconnect, then the battery back-up for the absolute encoders is good for only 10 days.

Task: To recognize different types of data.

Estimated Time: 1 hour

Overview: This module covers the differences between positional data, functional data and conditional data. When re-teaching a program it is important to know which of these you are dealing with; if you do not you may end up deleting or changing data you may not wish to change or delete.

Outline:

1. Positional Data
2. Functional Data
3. Conditional Data
4. MRH-5 Hierarchy

Objectives: Upon completion of this module the student will be able to:

1. Identify positional data.
2. Identify functional data.
3. Identify conditional data.
4. Identify how data is presented on the teach pendant.
5. Identify where each type of data must be located in the display window in order to make changes.
6. List the three tier hierarchy of the MRH-5 robot.

Study Guide

Instructions

_____ 1. Read - Types of Data, page 2-3.

_____ 2. Read - Positional Data, page 2-3.

_____ 3. Read - Functional Data, page 2-4.

_____ 4. Read - Conditional Data, page 2-6.

_____ 5. Read - MRH-5 Hierarchy, page 2-6.

Types of Data

There are three types of data on the MRH-5 robot, they are:

1. Positional Data
2. Functional Data
3. Conditional Data

Positional Data

Positional data is exactly what the name implies, the type of data entered is how the robot is going to position itself. The following are positional data:

1. **P** - POSITION move. Every program **must** start out with a **P** or POSITION move. A POSITION point is reached within +/- .004" (0.1mm) repeatability.

2. **Q** - QUICK move. A QUICK move is a POSITION move without the exact location of a position, it is also called a Continuous Motion Move. A continuous motion rounds off a position move making smooth movements from one point to the next. Caution! A QUICK point may be so rounded that the torch may "crash" into parts or fixtures that did not while block through taught points. Both POSITION moves and QUICK moves travel at a maximum of 6400"/min. at 100%.

3. **L** - LINEAR move. A LINEAR move is a straight line move from one point to the next. A LINEAR move is always used for straight line welding. LINEAR moves are programmed in inches per minute, (whereas POSITION and QUICK moves are programmed in % of maximum speed). The maximum speed for a LINEAR move is 234"/min..

4. **C** - CIRCULAR move. CIRCULAR points are programmed to make arcs or circles. A minimum of 3 points are needed to make a circle. The more points programmed in an arc or circle the smoother the arc or circle will be. The maximum speed for CIRCULAR moves is 234"/min..

Functional Data

Functional data includes welding data, delays (timers), and the END command terminating the completion of a program. The following are Functional Data:

1. **AS** - ARC START. When a weld is to begin an ARC START must be programmed. There can be as many ARC STARTS in a given program as desired. The ARC START contains four variables:

   1. Voltage
   2. Wire Feed Speed
   3. Travel Speed
   4. Gas Pre-flow Time

2. **AE** - ARC END. An ARC END ends the ARC START. If there are multiple ARC STARTS the one ARC END will terminate them all. The ARC END contains four variables:

   1. Crater Voltage
   2. Ending Wire Feed Speed
   3. Crater Fill Time
   4. Gas Post-Flow Time

3. **WS** - WEAVE START. A WEAVE START is programmed in to start a weave. There are five different ways in which the robot can weave. The most common axis to weave are axis 4 (a twisting motion) or axis 5 (the torch rotates back and forth). Weaving with axis 1, 2 or 3 involves the whole robot body moving in order to perform the weave. The WEAVE START contains four variables:

   1. Amplitude
   2. Cycle in Hertz
   3. Dwell Time on Sides
   4. Dwell Time in Center

   Amplitude is total width of the bead in inches (maximum of .78 in.). Hertz is the speed in which the weave occurs from side-to-side (maximum of 9.9 Hz).

4. **WE** - WEAVE END. A WEAVE END terminates a WEAVE START. The WEAVE END does not contain any variables.

5. **T** - TIMER. A TIMER is exactly what the name implies. TIMERS have nothing to do with welding, the welding timers are contained in the **AS**, **AE**, and **WS**.

6. **END** - Program END. All program must terminate with the END command.

The following are examples of how **AS**, **AE**, and **WS** would appear on the teach pendant window while programming:

ARC START

	P001	S005	M4
17.0V	210i	0.2S	0.2S
Arc Voltage	Wire Feed Speed	Welding Speed (IPM)	Preflow Time

ARC END

	P001	S005	M4
16.0V	210i	0.2S	0.2S
Arc Voltage	Wire Feed Speed	Crater Fill Time	Postflow Time

WEAVE START

	P001	S005	M4
0.5i	1.0H	0.2S	0.2S
Amplitude in Inches	Cycle in Hertz	Both Sides Dwell Time	Center Dwell Time

Conditional Data

Conditional data can be thought of as logic data. The following are conditional data:

1. **I/O** - INPUT/OUTPUT. An INPUT is information that is coming into the robot. An example would be a sensor was made and the robot program would act according to that input. An OUTPUT is information that is coming from the robot. An example of an output would be the robot activating a turntable at the completion of a welded part. INPUTS and OUTPUTS can be used in either jobs or programs.

2. **JUMP** - JUMP COMMAND. A JUMP COMMAND would allow a jump from one line in program (or job) to another line. The JUMP can be used in either jobs or programs.

3. **CALL** - CALL COMMAND. The CALL COMMAND is used only in a job to, for example, call up a program when a particular input comes true.

MRH-5 Hierarchy

All Miller robots use the same hierarchy of programming. It contains JOBS, PROGRAMS, and SEQUENCES. The position move, linear move, arc start, weave start, end, etc. are SEQUENCES or steps. All these steps, from the first Position move to the END command, make up a PROGRAM. If there is a need to put several PROGRAMS together they would go into a JOB. The hierarchy, then, is as follows:

JOBS

PROGRAMS

SEQUENCES

There can be a maximum of 255 JOBS with a maximum of 998 programs linkable per job. There can be a maximum of 255 PROGRAMS with a maximum of 1000 SEQUENCES per PROGRAM.

Task: To weld a part programming the MRH-5.

Estimated Time: 3 hours

Overview: This module begins the programming of the MHR-5 welding robot. Programming will begin with a simple program of running a straight bead, a circular bead and a weave bead. This module will also cover running the program back automatically.

Outline:

1. Teach Mode
2. Program Selection
3. Program Entering
4. Blocking Forward/Backward
5. Allocation of Programs
6. Running Programs Automatically

Objectives: Upon completion of this module the student will be able to:

1. Enter the Teach Mode and select a new program.
2. Enter a program in the MRH-5 robot.
3. Block through a program to determine if program is correct.
4. Allocate the written program to the Start Module Box.
5. Have the robot run the program and weld the the part together.

Study Guide

Instructions

_____ 1. Review - Print, page 3-3.

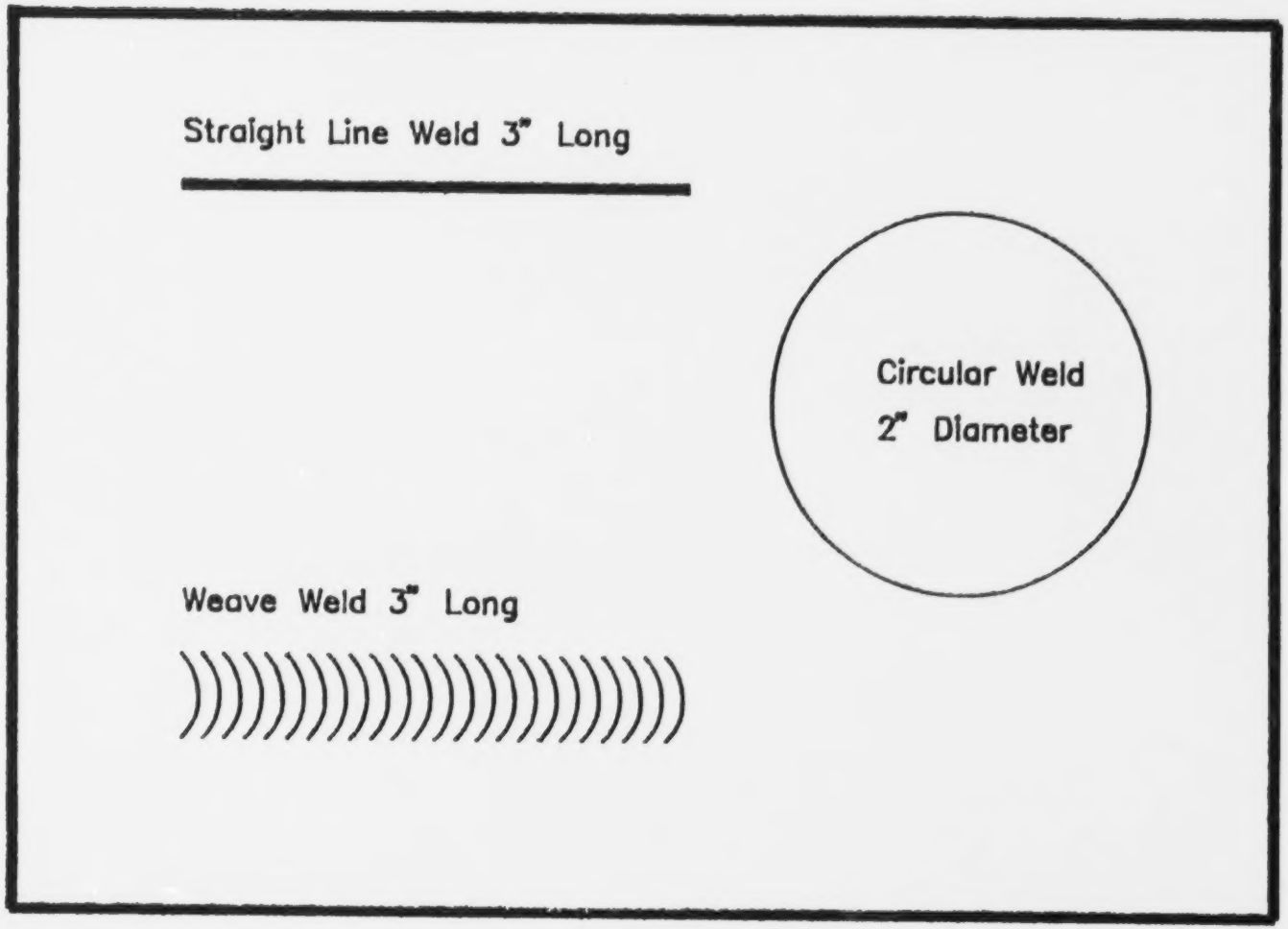
_____ 2. Complete - Lab 1/Programming, page 3-4.

_____ 3. Complete - Blocking Through A Program, page 3-14.

_____ 4. Complete - Continuous Blocking, page 3-15.

_____ 5. Complete - Running Program Automatically, page 3-16.

NOTE: The display examples used in this module may not match exactly with the actual displays you will be getting as you are programming. They are presented as a helpful guide so that you will know what the display should look like as you proceed through programming.


Straight Line Weld 3" Long
Circular Weld
2" Diameter
Weave Weld 3" Long

Lab 1 - Running Beads

This lab is a step-by-step approach to programming the MRH-5 robot. As you program you will note data that was entered in the previous step and current step. After the program is completed you will note three sets of data, think of this as PAST, PRESENT, and FUTURE. As you program the display may appear at one point or another like this:

```
          P001      S002      M4

   P            Q            60
```

Previous Recorded Data

Current Recorded Data

To begin programming the display should appear as follows:

```
PUSH  MODE  SELECT

BUTTON
```

1. Press - **TEACH/EDIT** key on the TEACH PENDANT or the **TEACHING** button on the OPERATION MODULE. The display will read:

```
PUSH  THE  PROGRAM  NO.

OR EDIT KEY
```

2. Press - **PROGRAM NO.** key. The display will read:

```
          P___      S000      M4
```

3. Enter - A program number (000 - 998) using the NO KEY. After entering a three digit number one of the displays shown below will appear. If the MODIFICATION P display appears, press the **Program No.** key again and enter a different number until the OK START TEACHING display appears.

```
        P001      S000      M4

OK  START  TEACHING
```

```
        P001      S000      M4

MODIFICATION  P
```

4. Press - **POSITION** key. The display will read:

```
        P001      S000      M4

              P             60
```

5. Press - **RECORD** key.

6. Press - **TEACH ENABLE** + the **AXIS** keys to move Robot to first position; about 1" above the start of the first linear weld.

7. Press - **POSITION** key.

8. Press - **CONT. MOTION** key.

9. Enter - **100** for 100%. The display will read:

```
        P001      S001      M4

P             Q            100
```

10. Press - **RECORD** key.

11. Move - Robot down so that "stick-out" is approximately 1/2". (**TEACH ENABLE** + the **AXIS** keys).

12. Press - **POSITION** key.

13. Press - **CONT. MOTION** key. A **P** should appear in the display as opposed to the **Q**.

14. Enter - **060** for 60% travel speed.

15. Press - **RECORD** key. The display will read:

	P001	**S003**	**M4**
Q	**P**		**60**

16. Press - **ARC START** key. The display will read:

	P001	**S003**	**M4**
0.0V	**0i**	**23i**	**0.0S**
Arc Voltage	Wire Feed Speed	Welding Speed	Preflow Time

17. Press - The right **DISPLAY SELECT** key. The first number will be flashing.

18. Enter - **180** for 18.0 volts. Notice the (.) does not have to be entered.

19. Press - The right **DISPLAY SELECT** key. The next number will be flashing.

20. Enter - **200** for 200 inches per minute of wire feed speed.

21. Press - The right **DISPLAY SELECT** key. The next number will be flashing.

22. Enter - **018** for 18.0 inches per minute of travel speed.

23. Press - The right **DISPLAY SELECT** key.

24. Enter - **02** for 0.2 seconds of gas pre-flow time.

25. Press - **RECORD** key.

26. Move - Robot to end of linear weld. (**TEACH ENABLE** + the **AXIS** keys).

27. Press - **LINEAR INT.** key. Note: Travel Speed was entered in **AS**

28. Press - **RECORD** key. The display will read:

	P001	**S005**	**M4**
AS	***L**	**18i**

Previous Recorded Data	Current Recorded Data

29. Press - **ARC END** key. The display will read:

	P001	**S005**	**M4**
0.0V	**0i**	**0.0S**	**0.0S**

Arc Voltage	Wire Feed Speed	Crater Fill Time	Postflow Time

30. Press - The right **DISPLAY SELECT** key. The first number will be flashing.

31. Enter - **165** for crater fill voltage.

32. Press - The right **DISPLAY SELECT** key.

33. Enter - **180** for crater fill wire feed speed.

34. Press - The right **DISPLAY SELECT** key.

35. Enter - **01** for crater fill time.

36. Press - The right **DISPLAY SELECT** key.

37. Enter - **05** for gas post-flow time.

38. Press - **RECORD** key. The display will read:

	P001	**S006**	**M4**
***L**	**AE**		

39. Move - The robot up about 1" above the weld.

40. Press - **Position** key.

41. Press - **CONT. MOTION** key. A Q should be displayed.

42. Enter - **100** for 100% quick speed.

43. Press - **RECORD** key.

44. Move - The robot to the weave weld position; about 1" above the plate.

45. Press - **RECORD** key. Note: If you are not changing the type of move, or the speed in which that move makes it is not necessary to enter that information in again.

46. Move - The robot down to about 1/2" stick-out.

47. Press - **POSITION** key.

48. Press - **CONT. MOTION** key. The **Q** will revert to a **P**.

49. Enter - **060** for 60% travel speed.

50. Press - **RECORD** key.

51. Press - **ARC START** key.

52. Enter - **185** for 18.5 volts. **225** for 225"/min. wire feed speed. **008** for 8"/min. travel speed. And, **02** for 0.2 seconds pre-flow. Use right **DISPLAY SELECT** key as before to move from one parameter to the next.

53. Press - **RECORD** key.

54. Press - **WEAVE START** key. The display will read:

	P001	**S010**	**M4**
0.0i	**0.0H**	**0.0S**	**0.0C**
Amplitude in Inches	Cycle in Hertz	Both Sides Dwell Time	Center Dwell Time in Seconds

55. Press - **WEAVE** key so that the LED will be lit near the 5. This invokes axis five as the weave axis.

56. Press - The right **DISPLAY SELECT** key. The first number will be flashing.

57. Enter - **050** for 0.5" width of weave.

58. Press - **DISPLAY SELECT**

59. Enter - **20** for 2.0 hertz speed from side to side.

60. Press - **DISPLAY SELECT**

61. Enter - **00** for 0.0 seconds dwell time on both sides of weave.

62. Press - **DISPLAY SELECT**

63. Enter - **00** for 0.0 seconds center dwell time.

64. Press - **RECORD** key. The display will read:

```
          P001      S011      M4
AS          WS                0
                              |
                        Weave Axis
                        Designator
```

65. Move - The robot to the end of the linear weave pattern.

66. Press - **LINEAR INT.** key.

67. Press - **RECORD** key. The display will read:

```
          P001      S012      M4
WS          *L                8i
```

68. Press - **WEAVE END** key.

69. Press - **RECORD** key. The display will read:

```
          P001      S013      M4
*L          WE
```

70. Press - **ARC END** key.

71. Press - **DISPLAY SELECT** key.

72. Enter - **165** for 16.5 volts. **180** for 180"/min. wire feed speed. **01** for 0.1 seconds crater dwell. And, **05** for 0.5 seconds post flow time.

73. Press - **RECORD** key.

74. Move - Robot to approximately 1" above weld.

75. Press - **POSITION** key.

76. Press - **CONT. MOTION** key.

77. Enter - **100** for 100%.

78. Press - **RECORD** key.

79. Move - Robot to circular weld pattern. (1" above plate)

80. Press - **RECORD** key.

81. Move - Robot down to about 1/2" stick-out.

82. Press - **POSITION** key.

83. Enter - **060** for 60% travel speed.

84. Press - **RECORD** key.

85. Press - **ARC START** key.

86. Enter - **180** for 18.0 volts. **200** for 180"/min.. **018** for 18"/min. travel speed. And **02** for 0.2 seconds pre-flow.

87. Press - **RECORD** key.

88. Move - Robot to next point in circle pattern.

89. Press - **CIRCULAR INT.** key.

90. Press - **RECORD** key. The display will read:

	P001	**S019**	**M4**
AS	***C1**		**18i**

91. Move - Robot to next point in circle pattern.

92. Press - **RECORD** key. The display will read:

	P001	**S020**	**M4**
***C1**	***C2**		**18i**

Asterisk Indicates
A Welding Operation

93. Move - Robot to next point in circle pattern.

94. Press - **RECORD** key. Note: Remaining CIRCULAR INT. will appear as **C2**.

95. Move - Robot to last point. Overlap first point 1/4".

96. Press - **RECORD** key.

97. Press - **ARC END** key.

98. Press - **DISPLAY SELECT** key.

99. Enter - **165** for 16.5 volts. **180** for 180"/min. wire feed speed. **01** for 0.1 seconds crater dwell time. **05** for 0.5 seconds post-flow time.

100. Press - **RECORD** key.

101. Move - Robot up approximately 1" above last recorded point.

102. Press - **POSITION** key.

103. Press - **CONT. MOTION** key.

104. Enter - **100** for 100%.

105. Press - **RECORD** key.

106. Move - Robot back to ABSOLUTE ZERO position.

107. Press - **END** key. This ends the program.

108. Press - **RECORD** key. The display will read:

```
          P001      S022      M4
*C2         AE
```

```
          P001      S024      M4
P           END
```

```
          P001      S000      M4
P           END         P     60
```

Blocking Through A Program

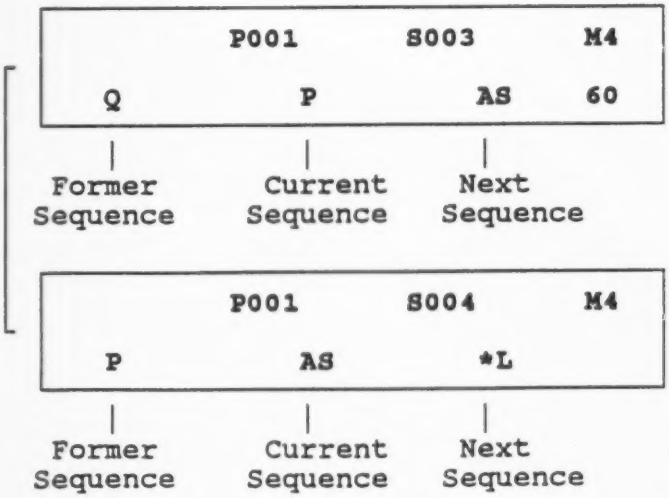
After completing a program it is essential that the operator "block" through a program to make sure it does what it is expected to do and not "crash" into anything. To block through the program just completed, proceed as follows:

1. Press & Hold - **TEACH ENABLE** key.
2. Press & Hold - **BLOCK FORW.** key. The robot will move to the first point programmed.
3. Continue - Holding the **TEACH ENABLE** key.
4. Continue - Pressing the **BLOCK FORW.** key.

Letting up on the **TEACH ENABLE** key will stop movement of the robot. Block through entire program until **END** is reached.

Pressing the **BLOCK BACK** key will move the robot backwards though the program.

As you progress forward the display will be shown as follows:



Continuous Blocking

Rather than pressing the **BLOCK FORW.** key each time you wish to make the robot move to its next point, the **BLOCK CONT.** key can be activated so that the robot will simulate how it would run automatically, (except at a reduced speed). To activate the key proceed as follows:

1. Press - **BLOCK CONT.** key. The LED should be lit.
2. Press & Hold - **TEACH ENABLE** key.
3. Press - **BLOCK FORW.** key.
4. Continue - Holding the **TEACH ENABLE** key.

It is not necessary to continue pressing the **BLOCK FORW.** key. Releasing the **TEACH ENABLE** key will terminate movement of the robot. To continue after the **TEACH ENABLE** key is released check to make sure **BLOCK CONT.** key is still lit and follow steps 2, 3 and 4 above.

If, at any time, you get stuck and get a BLOCK OP IMPOSSIBLE, simply press the **MODIFY** key. The **MODIFY** key and **RESET** key are used to get you going again when you get stuck, depending on the situation.

Remember! It is always necessary to BLOCK through a program every time a new one is written; no matter how comfortable you feel about programming or the program you have written. Blocking through a program will avert small errors that could turn into big catastrophes.

Running Program Automatically

After blocking through a program it is time to run it back automatically. A note of caution: A **Q** move will round to a greater extent during AUTO MODE than when simply blocking through a program because of the reduce speed during BLOCKING FORWARD/BACKWARD.

"Dry run" the program first by dis-enabling the **WELD ON** key. When you are satisfied with the way the program runs, enable the **WELD ON** key. Make sure you have a welding helmet.

To run a program automatically, proceed as follows:

1. Press - **TEACH/EDIT** key so that the LED is lit on the **EDIT** side of the key.

2. Press - **START NO.** key. The display will read:

```
P001      S004

ALLOCATE      S01      P251
```

Start Box Number — Last Program Number Allocated

3. Press - **PROGAM NO.** key. The display will read:

```
P001      S004

ALLOCATE      S01      P___
```

4. Enter - The program number of the program you wrote, (or JOB NO. if a JOB is to be run).

5. Press - **RECORD** key.

6. Press - **RESET** key.

7. Press - **TEACH/EDIT** key so that you are in the TEACH MODE.

8. Press - **RESET** key. The display will read:

PUSH	**MODE**	**SELECT**	**M4**
BUTTON			

9. Press - **AUTO** button on the OPERATION MODULE.

10. Press - **START** button on the OPERATION MODULE.

The robot will run the program once and then quit. To run program again, press the **START** button again.

As you saw, when you pressed the **START NO.** key the display read:

ALLOCATE S01 P___

This is allocating START BOX #1 to the program you select. There can be as many as six START BOXES in a given cell.

Task: To weld various joints with the MRH-5 robot.

Estimated Time: 3 hours

Overview: This module covers a welding project that involves a lap joint, tee joint and butt joint. This module is not a step-by-step instructional approach as was in the case in Module 3. Contained in this module is a Miller Robot Program Sequence Sheet which contains all the necessary information to complete the project. If you forget how to perform certain programming fucntions, refer back to previous modules.

Outline:

1. Enter Program in MRH-5 Robot
2. Blocking Forward/Backward
3. Allocating Program
4. Running Program Automatically

Objectives: Upon completion of this module, the student will be able to:

1. Correctly enter a program in the MRH-5 robot using a completed Program Sequence Sheet.
2. Block through the program to ensure success in programming.
3. Correctly allocate program to Start Module.
4. "Dry" run program through automatic mode to ensure success.
5. Run program with Weld On enabled.
6. Re-teach program if necessary.

STUDY GUIDE

Instructions

_____ 1. Follow - Program Sequence Sheet, page 4-3.

MILLER ROBOT PROGRAM SEQUENCE SHEET

Part No./Assembly Name TACK PROGRAM Date

Program Number Programmer

Wire Diameter .035 Wire Type E70S-3 Gas 75/25

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS
001	P				60%			HOME POSITION
002	Q				60%			MOVE ROBOT CLOSER
003	Q				60%			MOVE ROBOT CLOSER
004	P				60%			1st TACK, 1/2" STICK-OUT
005	AS		19.0	190	16		0.2	TACK
006	T					0.7		DWELL
007	AE		16.0	180		0.2	0.5	ARC END
008	P				60%			MOVE UP
009	Q				60%			MOVE TOWARD 2nd TACK
010	P				60%			2nd TACK, 1/2" STICK-OUT
011	AS		19.0	190	16		0.2	TACK
012	T					0.7		DWELL
013	AE		16.0	180		0.2	0.5	ARC END
014	P				60%			MOVE UP
015	Q				60%			SWIVEL TORCH HEAD
016	Q				60%			SWIVEL TORCH HEAD
017	Q				60%			SWIVEL TORCH HEAD
018	Q				60%			SWIVEL TORCH HEAD
019	Q				60%			3rd TACK (BUTT JOINT)

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS
020	P				60%			3rd TACK, 1/2" STICK-OUT
021	AS		19.0	190	16		0.2	TACK
022	T					0.7		DWELL
023	AE		16.0	180		0.2	0.5	ARC END
024	P				60%			MOVE UP
025	L				200			MOVE TO 4th TACK
026	P				60%			MOVE DOWN FOR TACK
027	AS		19.0	190	16		0.2	TACK
028	T					0.7		DWELL
029	AE		16.0	180		0.2	0.5	ARC END
030	P				60%			MOVE UP
031	Q				60%			MOVE CLEAR OF PART
032	P				60%			HOME POSITION
033	END							END OF PROGRAM

MILLER ROBOT PROGRAM SEQUENCE SHEET

Part No./Assembly Name WELD PROGRAM Date

Program Number Programmer

Wire Diameter .035 Wire Type E70S-3 Gas 75/25

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS
001	P				60%			HOME POSITION
002	Q				60%			MOVE ROBOT CLOSER
003	Q				60%			MOVE ROBOT CLOSER
004	P				60%			1st WELD (CIRCLE)
005	AS		19.0	210	12		0.2	START WELDING
006	C1				*12			-1/4 AROUND CIRCLE
007	C2				*12			-1/2 AROUND CIRCLE
008	C2				*12			-3/4 AROUND CIRCLE
009	C2				*12			LAST POINT ON CIRCLE
010	AE		16.0	180		0.2	0.5	ARC END
011	P				60%			MOVE UP
012	Q				60%			BACK & AWAY
013	Q				60%			SWIVEL TORCH HEAD
014	Q				60%			SWIVEL TORCH HEAD
015	Q				60%			SWIVEL TORCH HEAD
016	Q				60%			SWIVEL TORCH HEAD
017	Q				60%			OVER BUTT WELD
018	P				60%			AT BUTT WELD POSITION
019	AS		19.0	210	16		0.2	START WELDING

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS
020	L				*16			END POINT OF WELD
021	AE		16.0	180		0.2	0.5	ARC END
022	P				60%			MOVE UP
023	P				60%			POSITION TOWARD TEE
024	P				60%			AT TEE JOINT
025	AS		19.0	210	12		0.2	START WELDING TEE
026	L				*12			END POINT OF TEE
027	AE		16.0	180		0.2	0.5	ARC END
028	P				60%			UP & BACK FROM TEE
029	Q				60%			AROUND TEE (LEFT)
030	Q				60%			LEFT SIDE OF TEE
031	Q				60%			ABOVE NEXT WELD
032	P				60%			AT NEXT WELD
033	AS		19.0	210	12		0.2	START WELD
034	L				*12			1" SKIP WELD
035	AE		16.0	180		0.2	0.5	ARC END
036	P				60%			TO NEXT SKIP WELD
037	AS		19.0	210	12		0.2	START WELD
038	L				*12			1" SKIP WELD
039	AE		16.0	180		0.2	0.5	ARC END
040	P				60%			TO NEXT SKIP WELD
041	AS		19.0	210	12		0.2	START WELD
042	L				*12			1" SKIP WELD
043	AE		16.0	180		0.2	0.5	ARC END

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS
044	P				60%			UP & BACK FROM TEE
045	Q				60%			CLEAR PART
046	P				60%			HOME POSITION
047	END							END OF PROGRAM

Task: To weld your initials on a sheet of metal.

Estimated Time: 3 hours

Overview: This module will cover changing positional data and functional data. This module will also cover adding and/or deleting functional and positional data.

Outline:

1. Writing Initials Program
2. Sequence Jumping
3. Moving a Pre-Taught Point
4. Changing a Speed
5. Changing an Interpolation Method
6. Changing Weld Parameters
7. Inserting a Point
8. Deleting a Point

Objectives: Upon completion of this module, the student will be able to:

1. Weld their initials on a sheet of metal.
2. Jump from one sequence (point) in a program to another.
3. Re-teach a position previously entered to a new location.
4. Change the speed previously entered on an interpolation.

5. Change interpolation method.

6. Change welding parameters on Arc Starts, Arc Ends, and Weave Starts.

7. Insert a point in a program after the END.

8. Delete a point in a program after the END.

STUDY GUIDE

Instructions

_____ 1. Complete - Program Sequence for Initials, page 5-4.

_____ 2. Follow - Sequence Jumping, page 5-6.

_____ 3. Follow - Moving A Point, page 5-8.

_____ 4. Follow - Changing Speeds, page 5-9.

_____ 5. Follow - Changing Interpolation, page 5-11.

_____ 6. Follow - Changing Welding Parameters, page 5-12.

_____ 7. Follow - Inserting Information, page 5-13.

_____ 8. Follow - Deleting Information, page 5-14.

MILLER ROBOT PROGRAM SEQUENCE SHEET

Part No./Assembly Name _____ Date _____

Program Number _____ Programmer _____

Wire Diameter _____ Wire Type _____ Gas _____

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS

Sequence Jumping

SEQUENCE JUMPING allows the operation to move around the program without having to BLOCK FORWARD or BLOCK BACKWARD to get to a particular point in the program. It is especially helpful if you want the first point in the program the same at the last; as will be the case im almost all programs that you will write.

Let's use the example below as how the display will appear while performing a sequence jump. The first display would look something like this:

```
                          Sequence
                           Number
                             |
 ------------------------------------------
|          P010      S002     M4          |
|                                         |
| Q         P        L        60          |
 ------------------------------------------
   |         |        |
 Past     Present   Future
```

1. Press - **SEQUENCE NO.** key. The display will read:

```
 ------------------------------------------
|          P010      S002     M4          |
|                                         |
| S002   -   S___                         |
 ------------------------------------------
```

2. Enter - A sequence number you wish to jump to. The display will read:

```
 ------------------------------------------
|          P010      S010     M4          |
|                                         |
| S002   -   S010     P                   |
 ------------------------------------------
                         |
                Sequence Data At
                Jump Destination
```

3. Press & Hold - **TEACH ENABLE** key.

4. Press - **BLOCK FORW.** key. The display will read:

Sequence Number

	P010	**S010**	**B4**
L	**P**	**Q**	**60**
Past	Present	Future	

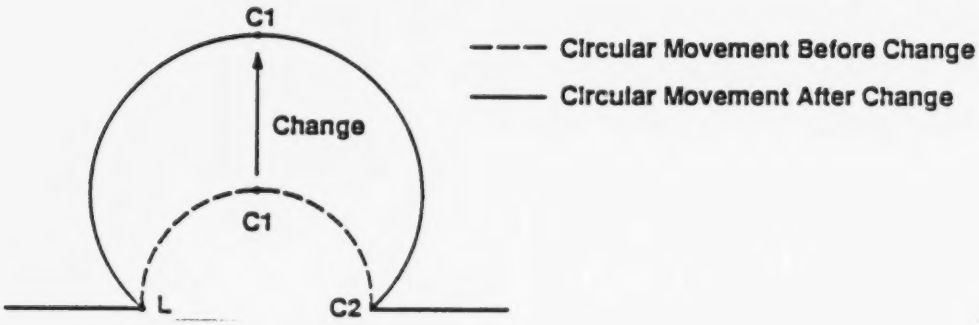
To perform additional sequence jumping, repeat steps 1 thru 4.

To have the last taught point in a program at the same location of first taught point use the SEQUENCE JUMP key. But, the program must have an END in it first. To do this, follow these steps, (just before ending a program):

1. Enter - An additional point (P) anywhere in space.
2. Press - **END** key.
3. Press - **SEQUENCE NO.** key.
4. Enter - **001** to jump back to the first point programmed.
5. Press - **BLOCK FORW.**
6. Press - **EDIT** key so that you are in the **EDIT** mode.
7. Press - **BLOCK FORW.** key to the last point programmed.
8. Press - **TEACH/EDIT** key.
9. Press - **MODIFY** key. The DISPLAY will tell you to do so.
10. Press - **POSITION** key.
11. Press - **RECORD** key.

Moving A Point

Using the example shown below, follow these steps to re-teach a point.



1. Press - **BLOCK FORW.** key so that the point you wish to change is in the CURRENT SEQUENCE position. (See Below)

	P010	S021	B4
L	C1	C2	60
Past	Present (Current)	Future	

2. Move - The robot to its new position.

3. Press - **RECORD** key. The new position is re-taught. Prove it to yourself by using the BLOCK FORWARD/BLOCK BACKWARD keys.

Changing Speeds

Sometimes during automatic playback the operator notices a certain speed going from one point to the next is too fast or too slow. To change the speed, follow these steps:

1. Press - **BLOCK FORW.** key until the point you wish to change is in the CURRENT SEQUENCE position. (See Below)

	P010	S010	B4
L	P	Q	60
Past	Present (Current)	Future	Moving Speed For Automated Mode

2. Press - The appropriate key, POSITION (P), LINEAR (L), CIRCULAR (C1 or C2), whichever is in the CURRENT SEQUENCE position. The screen will display:

P010	S010	M4
P		60
		Moving Speed For Automated Mode

3. Enter - New speed by using number pad. The display will now read:

P010	S010	M4
P		90
		Moving Speed For Automated Mode

4. Press - **RECORD** key. The display will show change:

	P010	**S010**	**M4**
L	**P**	**Q**	**90**

Moving Speed For Automated Mode

Changing Interpolation

Sometimes during programming the operator may wish to change an interpolation method, a QUICK move to a POSITION move or to a LINEAR move. The example below shows how to change POSITION interpolation to a LINEAR interpolation. There are several example in the MILLER MANUAL, page 5.157 - 5.161. To do this proceed as follows:

1. Press - **BLOCK FORW.** key until the point you wish to change is in the CURRENT SEQUENCE position. (See Below)

	P010	S005	B4
P	P	P	90
Past	Present (Current)	Future	

2. Press - **LINEAR INT.** key.

3. Press - **RECORD** key. The display will change to this:

	P010	S005	M4
P	L	P	90
Past	Present (Current)	Future	

Changing Welding Parameters

Changing welding parameters is as easy as changing movement data or the position of the robot. Proceed as follows:

1. Press - **BLOCK FORW.** key until the **AS**, **AE** or **WS** is in the CURRENT SEQUENCE position. (See Below)

	P010	**S015**	**B4**
P	**AS**	***L**	**90**
Past	Present (Current)	Future	

2. Press - **ARC START** key, (or appropriate weld function key). The display will read:

	P010	**S015**	**B4**
19.0V	**250i**	**20i**	**0.5S**

3. Press - **DISPLAY SELECT** key until appropriate weld parameter is flashing.

4. Enter - New welding parameter.

5. Press - **RECORD** key.

Many times a necessary move, (P, Q, L or C), or welding parameter (AS, AE, WS or WE) must be added after the END has been entered to terminate the teaching of a program. The **ADD COPY** key is used to insert this additional information. It is important to note that when the **ADD/COPY** key is pressed the inserted sequence will be placed AFTER the current sequence position. Example:

	P130	**S005**	**M4**
Q	**P**	**L**	**60**

Current

And you wish to add an **AS** before the **L**, the **ADD/COPY** key must be pressed when the **P** is in the current sequence position as shown above.

To perform this proceed as follows:

1. Press - **BLOCK FORW.** key until the sequence number you want to insert after is the current sequence position. (See Above)

2. Press - **ADD/COPY** key. The LED should be lit.

3. Enter - New data.

4. Press - **RECORD** key.

5. Press - **ADD/COPY** key. The LED should be off again.

	P130	**S005**	**M4**
P	**AS**	***L**	**18i**

Deleting Information

This part can be a little confusing, but with practice you will have no trouble getting rid of the undesired information. Depending on the type of information you wish to get rid of, i.e., Positional or Movement Data (**P**, **Q**, **L** or **C2**) or Function Data (**AS**, **AE**, **WS**, **WE**, **T**, etc.) would depend where that information would be located on the display.

Movement Data must be in the CURRENT SEQUENCE position and must be followed by a similar Movement Data, i.e. a **L** must be followed by a **L** move, a **C2** must be followed by a **C2** move (**C1** cannot be deleted), a **P** must be followed by either another **P** or **Q** and a **Q** must be followed by another **Q** or **P** move. If it is not, and you wish to delete the move anyway, you must first change the interpolation so that it matches the previous interpolation and then delete it. (See Changing Interpolation, page 4-9). In the first example below, you will be able to delete the ***L**, but you will not be able to delete the **P** in the second example.

	P130	S025	M4
AS	*L	*L	18i
Former	Current	Next	

	P130	S035	M4
P	P	C1	60
Former	Current	Next	

To delete Function Data, the data you wish to delete must be in the NEXT SEQUENCE position. In the example below, you will be able to delete the **WS** function provided it is in the NEXT SEQUENCE as shown.

```
                P130    S045    M4

   P            AS      WS

   |            |       |
Former       Current   Next
```

To perform a **DELETE/ERASE** proceed as follows:

1. Press - **BLOCK FORW.** key until the data you wish to delete is in the appropriate location on the display.

2. Press - **DELETE/ERASE** key.

```
                P130    S045    B4

   P            AS      *L

   |            |       |
Former       Current   Next
```

Task: To weld Desk Plaque with the MRH-5 robot.

Estimated Time: 3 hours

Overview: This module covers a welding project that involves circular welding and welding joints at angles.This module, like the last one, is not a step-by-step instructional approach. This module contains the Miller Robot Program Sequence Sheet but does notcontain any information. You must fill in the Program Sequence Sheet. It is best to complete the project first and latter fill in the Program Sequence Sheet. If you forget how to perform certain programming fucntions, refer back to previous modules.

Outline:

1. Enter Program in MRH-5 Robot
2. Blocking Forward/Backward
3. Allocating Program
4. Running Program Automatically

Objectives: Upon completion of this module, the student will be able to:

1. Correctly enter a program in the MRH-5 robot.
2. Block through the program to ensure success in programming.
3. Correctly allocate program to Start Module.
4. "Dry" run program through automatic mode to ensure success.
5. Run program with Weld On enabled.

6. Re-teach program if necessary.
7. Fill in results on a Program Sequence Sheet.

STUDY GUIDE

Instructions

_____ 1. Complete - Program Sequence Sheet, page 6-3.

MILLER ROBOT PROGRAM SEQUENCE SHEET

Part No./Assembly Name _____ Date _____

Program Number _____ Programmer _____

Wire Diameter _____ Wire Type _____ Gas _____

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS

SEQUENCE NUMBER	COMMAND	PORT NUMBER	ARC VOLTAGE	WIRE FEED SPEED	TRAVEL SPEED	CRATER TIME	PRE-FLOW POST FLOW	COMMENTS

TASK: To perform edit functions.

ESTIMATED TIME: 3 hours

OVERVIEW: This module will cover the functions performed in the edit mode. Such things as deleting programs and jobs; copying programs and jobs; program and job searching; and content checking.

OUTLINE:

1. Deleting Programs & Jobs
2. Copying Programs & Jobs
3. Searching For Programs & Jobs
4. Checking Contents of Programs & Jobs

OBJECTIVES: Upon completions of this module the student will be able to:

1. Delete a given program or job.
2. Copy a given program or job.
3. Search for programs or jobs that are recorded in memory.
4. Check to see what steps were recorded in a program or job that was recorded in memeory.

STUDY GUIDE

Instructions

_____ 1. Follow - Deleting A Program Or Job, page 7-3.

_____ 2. Follow - Copying Programs Or Jobs, page 7-4.

_____ 3. Follow - Searching For Programs Or Jobs, Page 7-5.

_____ 4. Follow - Checking The Contents Of Programs Or Jobs, page 7-6.

Deleting A Program Or Job

All Programs and Jobs are automatically protected after the END is entered to "end" the Program or Job. The protection, (shown on the display as a %), must be deleted first before you are allowed to delete the Program or Job number.

Deleting of entire Programs or Jobs must be done in the EDIT mode. To delete a Program or Job, proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.

2. Press - **PROGRAM NO.** or **JOB NO.** key, whichever is applicable. The display will read:

```
                    P011    S000

P___   (SRCH,  COPY,  DEL,)
```

3. Enter - The correct Program number or Job number, whichever is applicable.

4. Press - **BLOCK FORW.** key. The display will read:

```
                    P011    S000

%P011      PNT       3       14
```

5. Press - **DELETE/ERASE** key. The % key will disappear.

6. Press - **RESET** key.

7. Press - **PROGRAM NO.** or **JOB NO.** key, whichever is applicable.

8. Enter - The correct Program number or Job number again.

9. Press - **DELETE/ERASE** key. The Program or Job will be erased.

Copying Programs or Jobs

Sometimes it is necessary to make a Copy of a Program or Job, such as, when performing one of the SHIFT functions and you do not wish to have the original Program erased.

Copying a Program or Job must be done in the EDIT mode. To perform Copying, proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.
2. Press - **PROGRAM NO.** or **JOB NO.** key whichever one you wish to copy.
3. Enter - The correct Program number or Job number, whichever is applicable.
4. Press - **ADD/COPY** key. The display will read:

```
                    P011    S000

P011    -    P___   COPY ||
```

5. Enter - A Program number or Job number you wish to copy to.
6. Press - **RECORD** key. Copying is complete. The display will read:

```
                    P011    S000

    END    COPY
```

Searching For Programs or Jobs

Unless all Programs and Jobs are documented, one tends to forget what numbers were used for Programs and Jobs. Or, if you wish to see what Program and Job numbers may have been used for practice so that they can be erased, the SEARCH function is handy.

To perform SEARCH proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.

2. Press - **PROGRAM NO.** or **JOB NO.** key, whichever one you wish to search. The display will read:

```
                P011    S000

     J___ (SRCH, COPY, -)
```

3. Press - **BLOCK FORW.** key. The display will read:

```
                P011    S000

  %J001    LINE  #    5    1
```

% Sign Indicator For Deletion Protection	Number Of Data Lines In The Job	Order Of Job Entry In Memory

4. Press - **BLOCK FORW.** key to continue see what Programs or Jobs exist.

5. Press - **RESET** key to exist SEARCH mode.

Checking The Contents Of A Program Or Job

Another nice feature of the MRH-5 robot is the ability to quickly check the contents of a Program or Job in the EDIT mode. It is very quick and easy to check to see if a particular program contained weaves or how many points were programmed for an arc, for example. Also, if you performed a logic function and forgot how you did it, checking the contents of the Job will quickly reveal the solution.

To check the contents of a Program or Job, proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.
2. Press - **PROGRAM NO.** or **JOB NO.** key, whichever one you wish to check.
3. Press - **BLOCK FORW.** key.
4. Enter - The correct Program number of Job number, whichever is applicable.
5. Press - **READ** key. The display will read:

	P011	**S000**
J001	**1:**	**P012**

6. Press - The **BLOCK FORW.** key to continue reading the contents of the Program or Job.
7. Press - **RESET** key to exit the CONTENT CHECKING mode.

Production Counter Checking

The MRH-5 robot keeps track of the number of times a particular PROGRAM or JOB was run, provided the START NUMBER was not allocated to another PROGRAM or JOB prior to checking. To check the total production count of a PROGRAM or JOB allocated to START BOX #1, proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.

2. Press - **START NO.** key.

3. Press - **DISPLAY SELECT** key until it reads:

```
                P011    S000

ALLOCATE        END
```

4. Press - **DISPLAY_SELECT** key once more, and it will read:

```
                P011    S000

PD - QTY        S01       3
                 |         |
          Start Control   Production
             Number      Counter Total
```

Continuing to press the **DISPLAY SELECT** key will display the counter for START BOXES S02 through S06. Since we have only one START BOX there should be no production total for these remaining START BOXES.

TASK: To Check/Edit System Data.

ESTIMATED TIME: 3 hours

OVERVIEW: There is nothing to improve upon what Miller Electric has already written in SECTION 4 "System Set-Up". This module will serve as a quick reference guide as where to find certain charts found in SECTION 4. This reference guide will be found on the following page in the STUDY GUIDE portion of this module.

OUTLINE:

1. Zero Adjustment
2. Welding Torch Offset Adjustment
3. System Data 1 (Axis Soft-Limits)
4. System Data 2 (Wire Extension)
5. System Data 3 (Weld Parameters)
6. System Data 4 (Power Source Selection)
7. System Data 5 (Torch Length, Wrist Offset)
8. System Data 6 (Preset Data Conditions)
9. System Data 7 (Optional Equipment)
10. System Data 8 (For Factory Service Personnel)

OBJECTIVES: Upon completion of this module, the student will be able to:

1. Adjust the "zero" origin of the MRH-5 robot.
2. Adjust the tool point.
3. Edit or view SYSTEM DATA 1 through 5.

STUDY GUIDE

Instructions

_____ 1. Axis Deviation Measurement & Correction Chart,
Axis 1, page 4.101
Axis 2, page 4.110
Axis 3, page 4.105
Axis 4, page 4.25,
Axis 5, page 4.25

_____ 2. System Data 1 Soft Limit Chart, page 4.46

_____ 3. System Data 3 Weld Parameters Chart, page 4.55

_____ 4. Conditions Chart, page 4.60

_____ 5. Function Control Terminal, page 4.77

_____ 6. Output Signal Terminal, page 4.79

_____ 7. Input Signal Terminal, page 4.80

_____ 8. Power Source Selection Chart, page 4.95

TASK: To perform functions in EDIT mode.

ESTIMATED TIME: 3 hours

OVERVIEW: This module contains only a few examples of what is possible in the EDIT mode. A reference is made in the STUDY GUIDE of the module to the many functions available to the user in the EDIT mode. If more information is desired on various functions available please consult the Miller Operations Manual.

OUTLINE:

1. Job Linking
2. I/O Capabilities
3. Jumps
4. Job Editing
5. Workpiece Shift Check
6. Shift Functions
7. Body Weaving

OBJECTIVES: Upon completion of this module, the student will be able to:

1. Develop a JOB in the EDIT mode.
2. Understand how I/O's are entered.
3. Understand how the JUMP function works.
4. Re-teach (edit) an existing JOB.
5. Understand what a WORKPIECE SHIFT CHECK is.

6. Understand how the SHIFT FUNCTIONS work.
7. Describe the remaining weaving motions.

STUDY GUIDE

Instructions

_____ 1. Read - Job Linking, page 9-4.

_____ 2. Read - I/O Capabilities, page 9-6.

_____ 3. Read - Jumps For Programs, page 9-7.

_____ 4. Read - Jump/Call For Jobs, page 9-7.

_____ 5. Read - Job Editing, page 9-10.

_____ 6. Read - Keys For Job Editing, Miller Manual, pages 5.251 through 5.252.

_____ 7. Read - Workpiece Shift Check Function, Miller Manual page 5.240.

_____ 8. Read - Shift Functions, page 9-12.

_____ 9. Read - Body Weaving, page 9-14.

Job Linking

Many times it is necessary to link many Programs or other Jobs together to form one single Job. This can be accomplished by making one single Job. To program a Job, proceed as follows:

1. Press - **TEACH/EDIT** key so that you are in the **EDIT** mode.
2. Press - **JOB NO.** key. The display will read:

```
                P015    S000

J___   (SRCH, COPY, -)
```

3. Enter - A number from 000 to 999.
4. Press - **RECORD** key. This display will read:

```
                P015    S000

J022             1:
```

Begining Line Number
For Linking Operation

5. Press - **PROGRAM NO.** key. The display will read:

```
                P015    S000

J022             1:      P___
```

Location For Program
Number Selection

6. Enter - The number of the first Program.
7. Press - **RECORD** key.
8. Press - **PROGRAM NO.** key.
9. Enter - The number of the second Program.
10. Press - **RECORD** key.
11. Press - **END** key. The display will read:

```
                P015    S000

J022             3:       END
```

12. Press - **RECORD** key. This will read:

```
                P015    S000

      LINK    COMPLETED
```

This completes the first Job Linking operation of simply linking two programs together. Many other options are available as you will see latter.

I/O Capabilities

The MRH-5 Robot is capable of 10 inputs and 10 outputs with an expansion capability of 46 inputs and 34 outputs. The following are how inputs and outputs are recognized on the DISPLAY:

N - Input ON

F - Input OFF

S - Output SET (on)

R - Output RESET (off)

Inputs and Outputs can be placed in either Programs or Jobs. Typically in a Program and Output is SET to activate some external device, i.e. turntable, automatic clamps for fixtures, etc. Inputs are usually placed in a Program for a "wait until" situation.

In a Job Inputs are usually used to JUMP to a Sequence Line when the Input comes true and perform whatever is in that line. Outputs can be used in a Job for the same purpose as performed in a Program. It all depends on the application.

To get to the I/O's in a Program or Job, proceed as follows, (assume that you are in some Sequence Step in a Program or Job):

1. Press - **I/O** key.

2. Press - **DISPLAY SELECT** key until you reach desired function, **N, F, S, R.** (See Below)

3. Enter - Appropriate Input number or Output number.

4. Press - **RECORD** key.

JUMPS For Programs

JUMPS can be performed in either a Program or Job. In the case of a Program they will appear as **JN**, **JF**, **JC**, or **JP**.

Conditional Jumps
- JN: Jump when Input port signal is ON.
- JF: Jump when Input port signal is OFF.
- JC: Jump when internal counter counts down form the assigned count value.

JP: Jump whenever command is the current sequence during program operation.

When selecting any of the above:

1. Press - **JUMP/CALL** key once.

2. Press - **DISPLAY SELECT** key until the desired **JUMP** is reached.

For more information on **JUMPS** consult the Miller Manual, pages 5.233 to 5.240.

JUMP/CALL For Jobs

In a Job **Call** statements are generally used to call to Programs based on an internal counter or I/O condition. **Jump** statements are generally used to jump to other sequence lines within the Job based on an internal counter or I/O condition. An example would be, (assume a Job is being written):

1. Press - **JUMP/CALL** key twice. The display will read:

```
                P015    S000

J 001     5: J
```

```
                P015    S000

J 001     5: C
```

2. Press - I/O key. The display will read:

```
                P015    S000

J 001     5: C   N___
```

Location For Input
Port Number Selection

3. Enter - **001** using numeric keys (or appropriate input).

4. Press - **PROGRAM NO.** key. The display will read:

```
                P015    S000

J 001     5: C   N001    P___
```

5. Enter - **003** using numeric keys (or appropriate Program).
The display will read:

```
                P015    S000

J 001     5: C   N001    P003
```

6. Press - **RECORD** key.

This example will jump to Program 003 when input 001 comes true. Again, an internal counter could have been used as opposed to an input to call a Program.

On this page is an example of a Jump to a line number within the Job based on an internal counter. In the Job in this example, each time the Job sequences through line 5 of Job 001 the internal counter (T010, timer 010) decrements by one until it reaches T000. Upon reaching zero, line 002 of Job 001 is then performed and the internal counter is reset back to T010.

1. Press - **JUMP/CALL** key once. The display will read:

```
                P015    S000

J 001     5: J
```

2. Press - **TIMER** key. The display will read:

```
                P015    S000

J 001     5: J   T___
```

3. Enter - **010** with the numeric keys (or appropriate counter). The display will read:

```
                P015    S000

J 001     5: J   T010     ___
```

4. Enter - **002** with the numeric keys (or appropriate line #). The display will read, (Press **RECORD** when finished):

```
                P015    S000

J 001     5: J   T010     002
```

Job Editing

If you make a mistake during the Job Linking operation it can be edited by proceeding as follows:

1. Press - **END** key to terminate Job Linking.

2. Press - **DISPLAY SELECT** key forward or backward until the Job line number you wish to edit is reached.

3. Press - **DELETE/ERASE** key to get rid of a line.

   or

   ADD/COPY key to insert a line of instruction.

4. Enter - Appropriate data and **RECORD** key if using **ADD/COPY**.

When DELETING, destination lines will automatically be updated for JUMPS and CALLS.

Example #1

1 :	P001		1 :	P002	
2 :	P002		2 :	J-N001	001
3 :	J-N001	001	3 :	J-F003	001
4 :	J-F003	002	4 :	END	
5 :	END				

Before Deletion — Line #1 is Deleted — After Deletion

Example #2

1 :	P001		1 :	J-N001	004
2 :	J-N001	005	2 :	J-T003	004
3 :	J-T003	005	3 :	P002	
4 :	P002		4 :	P005	
5 :	P005		5 :	END	
6 :	END				

Before Deletion ———————————— After Deletion

Other than DELETING or ADDING a line of instruction, you may also edit existing lines in a Job. To change from a Jump to a Call instruction, for example, proceed as follows:

1. Press - **DISPLAY SELECT** key until appropriate line appears:

```
                P015    S000
J 001     3: J   T010     002
```

2. Press - **JUMP/CALL** key twice. The display will change to:

```
                P015    S000
J 001     3: C
```

3. Press - **I/O** key.
4. Press - **DISPLAY SELECT** key until input is OFF (**F**).
5. Enter - **004** for the input.
6. Press - **PROGRAM NO.** key.
7. Enter - **001**. The new display will read:

```
                P015    S000
J 001     3: J   F004    P001
```

8. Press - **RECORD** key when finished.

Shift Functions

There are five types of shifts available in the MRH-5 robot. They are:

1. Parallel Shift

2. 3-Dimensional Shift

3. Mirror Image Shift

4. Parallel Direct Input Shift

5. Enlargement/Reduction Shift

For more information on Shifts refer to pages 5.274 through 5.287 in the Miller Robot Manual. The example shown below is a Parallel Shift, since this type is the most common. There are two types of Parallel Shifts: one involves just moving the robot to a parallel position; the other involves knowing the exact distance (in inches) and input that amount. The example below is one of the latter.

All the shifts will shift, or move, the program being shifted to a new location. If there are two or more identical parts to be welded the shift function will allow a complete shift of the program. If, for example, there are three identical parts, you must have three programs. One will be the taught program, the second will be a copy using the **ADD/COPY** function and then shifted using the **SHIFT** function, the third will also be a copy then shifted to the third position.

After making a copy (if making duplicate programs):

1. Press - **SHIFT** key. The display will read:

	P015 S010	**B4**
PARALLEL SHIFT	**- REC**	

2. Press - **DISPLAY SELECT** key until the display reads:

		P015	S010	B4
SFT	VOL	x = +	0.00	- REC

3. Enter - The amount in inches the distance to offset in the X. If zero, enter 0. Use the Increase (**INC.**) or Decrease (**DEC.**) keys until desired value is reached. Using the **QUICK** key in combination with the **INC.** or **DEC.** speeds up the process. The display will read:

		P015	S000	M4
SFT	VOL	x = +	27.00	- REC

4. Press - **RECORD** key. The display will read:

		P015	S000	M4
SFT	VOL	y = +	0.00	- REC

5. Repeat - Step 3 for axis **Y** and **Z**. Press **RECORD** after each data entry.

Body Weaving

Most often, axis 4 or 5 will be used when performing a weave function. However, there may be times when a different type of weave is desired. To access additional weaves (Body Weaves) proceed as follows (assume you are presently writing a program):

1. Press - **WEAVE** key twice, the LED should not be illuminated. The display will read:

```
          P015    S005      M4
WSF   PATTERN            NO. 1
```

May Also Be 0

2. Enter - Desired weave pattern, **0** - Flexible Pattern.
   1 - Fixed Pattern.

3. Press - **RECORD** key. The display will read:

```
          P015    S005      M4
WSF   PATTERN            NO. 0
```

4. Enter - **0** for REPEAT, **1** for LOOP. See below:

```
          P015    S005      M4
REPEAT: 0   LOOP: 1        - 0
```

5. Press - **RECORD** key. The display will read:

	P015	**S005**	**M4**
W1	**L**	**9i**	**0.0i**
Pattern Point	Movement Data	Weaving Speed	Dwell Time

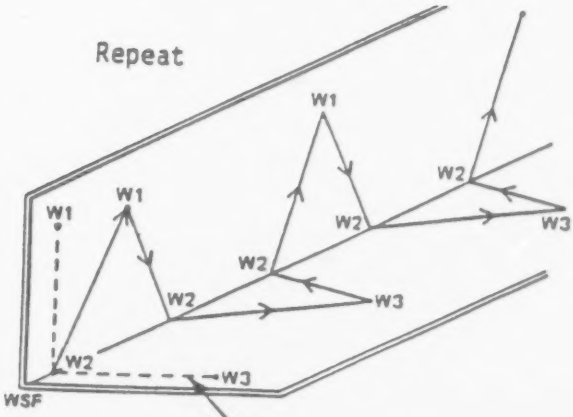
6. Press - **TEACH ENABLE** key to move robot to **W1** position.

7. Enter - Appropriate data for first move by using **DISPLAY SELECT** key and **INC.** or **DEC.** keys.

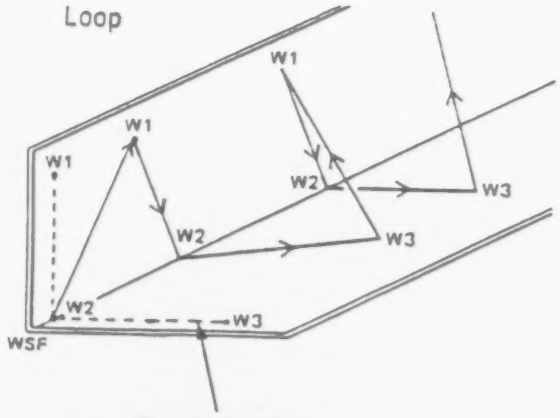
8. Press - **RECORD** key.

9. Repeat - Steps 6, 7 and 8 to teach points **W2**, **W3**, etc. Up to six points can be taught. If less then six points are taught then you must terminate weave function by pressing the **END** key. If six points are taught then the END is automatic and the END key does not have to be pressed.

See pages 5.259 through 5.267 in the MIller Robot Manual for more information.



Teaching Pattern:
An Example Of Repeat (0) Operation



Teaching Pattern:
An Example Of Loop (1) Operation